

WHAT IS CLAIMED IS:

1. A solid-state imaging device in which a pixel-by-pixel array of photoelectric conversion sections each generate an 5 electrical charge in accordance with an amount of light entering the photoelectric conversion section, and the electrical charges generated by the photoelectric conversion sections are converted to an electrical signal to be output, comprising:

10 a color filter layer disposed above the photoelectric conversion sections, the color filter layer allowing light of a specific wavelength to pass therethrough;

upper lenses disposed above the color filter layer, the upper lenses causing incident light to be converged so as to enter the color filter layer; and

15 intralayer lenses disposed between the color filter layer and the photoelectric conversion sections, each intralayer lens causing the light converged by each upper lens to be further converged so as to enter a corresponding one of the photoelectric conversion sections,

20 wherein each intralayer lens has a Fresnel lens structure.

2. The solid-state imaging device according to claim 1, wherein each intralayer lens includes:

25 a center lens having a circular and curved surface

whose center is on an optical axis of the center lens; and
at least one annular lens disposed on the outside
of the center lens, the at least one annular lens having a annular
and belt-like face which is concentric to the center lens with
5 respect to the optical axis.

3. The solid-state imaging device according to claim 2,
wherein a refractive index of the center lens and a refractive
index of the at least one annular lens are not equal.

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4. The solid-state imaging device according to claim 3,
wherein a refractive index of the center lens and a refractive
index of the at least one annular lens increase toward outside
and away from the optical axis of the center lens.

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5. The solid-state imaging device according to claim 3,
wherein a refractive index of the center lens and a refractive
index of the at least one annular lens decrease toward outside
and away from the optical axis of the center lens.

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6. The solid-state imaging device according to claim 2,
wherein a width of the at least one annular lens along a radius
direction thereof decreases toward outside and away from the
optical axis of the center lens.

7. The solid-state imaging device according to claim 1,
wherein each intralayer lens comprises SiN (silicon nitride).

8. A method for producing a solid-state imaging device
5 in which a pixel-by-pixel array of photoelectric conversion
sections each generate an electrical charge in accordance with
an amount of light entering the photoelectric conversion section,
the solid-state imaging device having intralayer lenses provided
between the photoelectric conversion sections and the color filter
10 layer, the method comprising:

an insulative film forming step of forming an insulative
film above a layer of the photoelectric conversion sections;

15 a lens forming step of forming lenses above the
insulative film, each lens being immediately above a corresponding
one of the photoelectric conversion sections;

a resist forming step of forming a resist layer so as
to cover the insulative film and the lenses;

20 a hole forming step of forming a cylindrical hole in
the resist layer so as to be located above each lens, each hole
having a circular bottom face centered around an optical axis of
the lens and having a diameter smaller than a diameter of the lens;

an etching step of etching an interior of the hole in
a manner to retain a surface configuration of a central portion
of the lens; and

25 a resist layer removing step of removing the resist

layer.

9. A method for producing a solid-state imaging device in which a pixel-by-pixel array of photoelectric conversion sections each generate an electrical charge in accordance with an amount of light entering the photoelectric conversion section, the solid-state imaging device having intralayer lenses provided between the photoelectric conversion sections and the color filter layer, the method comprising:

10 an insulative film forming step of forming an insulative film above a layer of the photoelectric conversion sections;

15 a center lens forming step of forming center lenses above the insulative film, each lens being immediately above a corresponding one of the photoelectric conversion sections and having a diameter which is about 50% to about 70% of a period with which the pixels are formed;

20 a planarizing film forming step of forming a planarizing film to provide a planar surface covering the center lenses, the planarizing film comprising a material having a smaller refractive index than that of the center lenses;

25 a resist forming step of forming a cylindrical piece of resist on the surface of the planarizing film so as to be located above each center lens, each resist piece having a circular bottom face centered around an optical axis of the center lens and having a diameter equal to a diameter of the center lens;

a planarizing film reducing step of removing the planarizing film except for portions lying below the resist pieces;

a lens film forming step of forming a lens film of a lens material so as to cover the insulative film and the planarizing film; and

5 side wall forming step of forming a side wall to become an annular lens surrounding each center lens, by etching the lens film to a sufficient depth to expose the planarizing film.

10 10. The method according to claim 8, wherein a sequence including the planarizing film forming step, the resist forming step, the planarizing film removing step, the lens film forming step, and the side wall forming step is repeated a plurality of times to form a plurality of annular lenses surrounding each center

15 lens.

11. The method according to claim 9, wherein the plurality of annular lenses have the same refractive index.

20 12. The method according to claim 9, wherein the plurality of annular lenses have at least two different refractive indices.

25 13. The method according to claim 9, wherein a width of each annular lens along a radius direction thereof decreases

toward outside and away from the optical axis of the center lens.